APPENDIX A

TECHNICAL NOTES

Technical Notes

This appendix discusses the study methodology as well as various other technical aspects that the reader should consider when interpreting the data presented in this report. In addition to the current 1996 survey, the discussion includes the original 1988 survey, and the 1990, 1992 and 1994 surveys. The following topics are covered:

- Universe and sample

- The surveys

- Data collection and response rates

- Item nonresponse

- Weighting

- Reliability of survey estimates

- Data considerations, definitions, and limitations

Universe and Sample

A. Academic Institutions

1988 Survey. The 1988 survey was designed to provide estimates for all research-performing academic institutions, as defined in the National Science Foundation's (NSF) Fiscal Year (FY) _1983 Survey of Scientific and Engineering Expenditures at Universities and Colleges._ The universe datafile for the 1983 expenditures survey included all universities and colleges that offered a master's or doctorate degree in science and engineering (S&E), all others that reported separately budgeted S&E research and development (R&D) expenditures of $50,000 or more, and all Historically Black Colleges and Universities (HBCUs) that reported any R&D expenditures. This datafile represented the most recent available universe survey of R&D expenditures at academic institutions. The datafile contained a total of 566 institutions.

All HBCUs in the frame were included in the sample with certainty (N = 30), and a stratified probability sample of 223 institutions was selected from among the remaining institutions in the frame. These institutions were first stratified by control (public versus private) and highest degree awarded in S&E (doctorate-granting versus nondoctorate-granting). A minimum sample size of 25 was set for each of the four resulting strata, and the remaining sample was allocated to strata in proportion to the "size" of each stratum. Stratum size was defined as the square root of the aggregate R&D expenditures in S&E of the institutions in the stratum. Academically administered Federally Funded Research and Development Centers were excluded from this survey. Within strata, institutions were sampled with probability proportionate to size. Again, size was defined as the square root of the institution's fiscal year 1983 R&D expenditures.

Following the selection of an initial sample of 253 institutions, NSF determined that several of the sampled institutions were out of the scope of the survey. Out of scope institutions included those in outlying territories, military academies, and three highly specialized institutions considered inappropriate, given the nature of their programs. Elimination of these out of scope cases reduced the final sample to 247 institutions, of which 29 were HBCUs and 99 had (or were) medical schools.

Institutions in the sample accounted for more than 75 percent of all academic R&D expenditures in fiscal year 1983 and encompassed at least 70 percent of the spending in each major S&E discipline. The sample represented a weighted national total of 525 institutions. The composition of this survey universe, by type of institution, is shown in Table A-1.

Table A-1
Number of institutions in the survey universe of research-performing colleges and universities: weighted estimates, 1988

INSTITUTION TYPE	Total	Non-HBCUs		HBCUs
		Public	Private	
Total	525	296	200	29
octorate-granting	293	190	100	3
Top 100 in research expenditures	100	69	31	0
Other	193	121	69	3
ondoctorate-granting	232	106	100	26

KEY: HBCU = Historically black colleges and universities

SOURCE: National Institute of Health, *The Status of Biomedical Research Facilities: 1996,* Bethesda, MD, 1997

1990 Survey. The institution sample for the 1990 survey was the same as for the 1988 survey, except for the following two changes:

- The sample was updated to reflect recent R&D patterns as shown in NSF's fiscal year 1988 R&D expenditures survey, which collected expenditures data for all institutions in the survey frame for the first time since 1983. School-by-school comparisons of these two databases resulted in the identification of 12 institutions whose 1988 R&D expenditures would have given them substantially higher probabilities of selection than they had using 1983 expenditures. These 12 institutions were made certainty selections for the 1990 survey. Five were already in the sample, having been noncertainty selections in the 1988 study; the other seven were added to the sample for the 1990 survey.

- One institution from the 1988 sample became out of scope when it distributed its assets among other institutions in the same state system. Therefore, this institution was eliminated from the sample.

These same changes noted above produced a net increase of six institutions, increasing the sample size to 253 in 1990. The universe represented by the sample, however, did not change. The sample design for the 1990 survey is summarized in Table A-2.

1992 Survey. The institution universe and sample for the 1992 survey were the same as for the 1990 survey, except for three changes:

- Shortly after the sample for the 1990 facilities survey was selected, NSF conducted a universe survey of all HBCUs and identified an expanded group of 70 that reported separately budgeted R&D expenditures in S&E disciplines. A sample of 46 of these 70 institutions was selected for the 1992 facilities survey, with probability proportionate to size. Size was measured as the square root of the institution's reported 1989 R&D expenditures (a minimum size measure of $10,000 was used to afford the smallest institutions some possibility of selection).

- The sample was expanded to include all institutions in the top 100 in 1988 R&D expenditures. Only two institutions from this analytically important category were not already in the sample, and they were made certainty selections in 1992.

- To improve the precision of estimates for nondoctorate-granting institutions, an expanded sample of 91 institutions in this category was selected (excluding HBCUs, which were sampled separately). The sample included all (10) public institutions with 1988 R&D expenditures of $2 million or more, and all (11) private institutions with 1988 expenditures of $1 million or more. Institutions with R&D expenditures below these cutoffs were sampled with equal selection probabilities.

Of the 91 sampled nondoctorate-granting institutions, nine were later determined to be out of scope, since they reported in the 1992 facilities survey that they had no S&E research space and also reported in the 1988 R&D expenditures survey (which provided the basis for the sampling frame) that they had less than $50,000 in separately budgeted R&D expenditures. The exclusion of these out of scope institutions reduced the sample of nondoctorate-granting institutions to 82. The sample design for the 1992 survey is summarized in Table A-2.

1994 Survey. The institution universe and sample for the 1994 survey closely matched the 1992 survey, with the following exceptions:

- The 1991 R&D expenditures survey information was used to generate the top 100 stratum. Three institutions were added to the top 100 list, and three institutions were moved out. The expenditures data also were used to calculate the measure of size for the doctorate-granting institutions. The 1988 expenditures survey data were used to calculate size measures for the nondoctorate-granting institutions, since subsequent surveys did not yield complete information for the nondoctorate-granting institutions.

- Institutions expending less than $50,000 in R&D in S&E fields were removed from the frame prior to sampling. In 1992, they were selected with probability proportionate to size and then excluded after contact.

- FICE codes were updated for 50 institutions.[1]

- Six institutions were misclassified with the 1992 sampling list as nondoctorate-granting, when in fact they did award S&E doctorates. These misclassifications were corrected.

- Random (rather than systematic) draws from the strata were employed.

- The HBCUs selected with certainty were redefined to include 28 from the 1990 list,[2] plus all of the new institutions selected with certainty in 1992. This meant that a total of 33

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[1] This is the Federal Interagency Commission on Education number assigned by the Department of Education. Numbers beginning with 66 are for accredited institutions which have not yet received a FICE number. These are identification numbers for the record file only.

[2] One of the 29 HBCUs selected with certainty in 1990 was excluded because it had no current funded R&D at the time the sample was taken.

HBCUs was selected with certainty and 12 others were selected with probability proportionate to size.

Of the 314 sampled institutions, five nondoctorate-granting institutions were later determined to be out of scope, since they reported no S&E research space. The exclusion of these out of scope institutions reduced the sample to 309.

1996 Survey. The institution universe and sample for the 1996 survey were the same as the universe and sample from the 1994 survey. No institutions were added, and none was deleted.

Seven of the nondoctorate-granting institutions in the sample reported no S&E research space in their survey response and were determined to be out of scope. The exclusion of these seven institutions reduced the sample to 307.

The sample design for the 1990, 1992, 1994, and 1996 surveys is summarized in Table A-2. (See Appendix B for a list of 1996 sampled institutions.)

Table A-2
Number of institutions in the 1990, 1992, 1994 and 1996 samples of
research-performing universities and colleges

	NON-HBCUs								HBCUs			
	Public				Private							
INSTITUTION TYPE	1990	1992	1994	1996	1990	1992	1994	1996	1990	1992	1994	1996
Total	138	157	153	156	86	100	93	98	29	46	41	44
ate-granting 100 in research expenditures 	115 67 48	117 69 48	113 68 45	116 70 46	58 31 27	58 31 27	53 29 24	57 30 27	3 0 3	5 0 5	8 0 8	10 0 10
torate-granting	23	40	40	40	28	42	40	41	26	41	33	34

(1) The sample initially included nine other institutions that were later classified as out of scope of the study.

KEY: HBCU = Historically black colleges and universities

SOURCE: National Institute of Health, *The Status of Biomedical Research Facilities: 1996,* Bethesda, MD, 1997

B. Research Organizations and Hospitals

In preparation for the 1988 survey, NIH provided listings of all hospitals and nonprofit research organizations that received extramural research funding from NIH during FY 1986. A small number of agencies and institutions that primarily conduct public information dissemination or other nonresearch activities were eliminated from the listings.

Samples of 50 hospitals and 50 research organizations were selected from the listings, with probability proportional to size, as measured by total dollar awards from NIH in FY 1986. It was determined during data collection, however, that there was some duplication in the listings. Some nonprofit research institutions were located within hospitals and shared the same facilities, and some of the research organizations were units within other sampled research organizations. In addition, some of these institutions have been classified as out of scope of the survey based on their reports that they do not contain any research space (e.g., because their research grants have expired or because their current research is conducted entirely off premises). Elimination of duplicate and out-of-scope institutions has reduced the number of sampled research organizations to 47 and the number of sampled hospitals to 42.

In 1994, an updated list of hospitals and research organizations that received extramural research funding from NIH during FY 1992 provided the sampling frame. Fifty hospitals and 50 research organizations were initially selected. One institution was eliminated from each of these samples either because it was a duplicate or out-of-scope for this study. This resulted in a sample of 49 hospitals and 49 research organizations.

Like the academic institutions' sample, the 1996 sample of hospitals and research organizations was the same as that used in 1994.

The Survey Questionnaire

The 1996 survey questionnaire, reproduced in Appendix B, updated information collected during earlier (1988, 1990, 1992 and 1994) surveys regarding several topics:

- The total net assignable square feet (NASF) of space in science and engineering disciplines, and the NASF used for organized research;

- The total amount of space in all non-science fields, and an overall space total across all academic fields;

- The amount of research space that is leased by the institution;

- The condition of research facilities in each S&E field;

- The adequacy of the current amount of research space, by S&E field;

- The project costs, NASF, and sources of funds for major repair/renovation ($100,000 or more) and construction activities initiated in fiscal years 1994 and 1995 and scheduled for fiscal year 1996 and 1997;

- Expenditures for research facility repair/renovation projects in the $5,000 to $100,000 range;

- The existence of an approved institutional plan that included deferred space requiring repair/renovation or new construction;

- The number of years included in the plan;

- The estimated costs for needed repair/renovations and new construction, by S&E discipline, that the institution was not scheduled to begin during fiscal year 1996 or 1997;

- Scheduled expenditures in fiscal year 1996 or 1997 for construction and repair/renovation of research laboratory animal facilities; and

- The status of the institutions relative to the cap of tax-exempt bonds (applicable only to private universities and colleges).

In addition to collecting updated information on the above topics, the 1996 questionnaire expanded five questions to collect additional information that had not been addressed previously. The additional information included:

- the additional amount of space needed in a discipline if the current amount was reported to be inadequate;

- the amount of space in a discipline that was scheduled to undergo major renovation or replacement if any space in that discipline was reported to require major renovation or replacement;

- the central campus infrastructure costs ($100,000 or more) scheduled for repair/renovation or new construction in fiscal year 1996 or 1997;

- the central campus infrastructure costs for repair/renovation or new construction that were needed but not funded; and

- the estimated costs not in an institutional plan for needed repair/renovations and new construction, by S&E discipline, that the institution was not scheduled to begin during fiscal year 1996 or 1997.

One new question was added to the 1996 survey that asked for additional comments from the institutions. The optional, open-ended question was designed with two purposes in mind. It allowed the institutions to:

- provide information that numerical data could not capture; and

- help identify new areas of concern relating to S&E research facilities which, in the future, would assist in the development of new survey questions.

Finally, the response categories for two questions were modified slightly in 1996 from previous years' surveys. The questions are about the adequacy of the amount and the condition of S&E research space (see "Data Considerations" later in this appendix for details).

Disk-Based Survey

For the first time since the Facilities Survey begin in 1988, institutions had the option in 1996 of responding to the survey either on the printed questionnaire or through a disk-based version of the survey. Institutions were encouraged to utilize the disk version, which contained their 1994 responses. The disk version was programmed to detect logic errors across the 1996 survey items, as well as inconsistencies from the institution's 1994 responses.

Data Collection and Response Rates

In October 1995, a letter from Judith Vaitukatis, Director of the National Center for Research Resources at the National Institutes of Health was sent to the president or director of each sampled institution, asking that the institution participate in the study and that a coordinator be named for the survey. A few days following the two-week deadline for returning the coordinator identification card, telephone follow-up was conducted with all sampled institutions that had not yet identified a survey coordinator. Survey materials, including both a printed survey and DOS-based disk survey, were mailed to the coordinators in mid-November by Federal Express. The questionnaire and cover letter requested return of the completed survey by December 31, 1995. Nonresponse followup began in mid-January and continued through March 1996.

As printed versions of the survey were returned, responses were entered on the disk version to run the series of logic and arithmetic checks. Responses returned on the disk version were available immediately for analysis. Telephone follow-up was conducted with the institutions to resolve data inconsistencies discovered during analysis.

The overall response rate for the NIH-sampled institutions in the 1996 survey was 93 percent. As Table A-3 indicates, response rates were quite high (94 percent or above) for all academic institution categories.

Table A-3
Academic institution response rates, by category
of institution: 1996

| | Number of institutions | | |
INSTITUTION CATEGORY	Sample[1]	Respondents	Response rate
Total	307	298	97

Doctorate-granting	178	173	97
Top 100 in research expenditures	100	100	100
Other	78	73	94
Nondoctorate-granting	85	81	95
Public	161	156	97
Private	102	98	96
HBCUs: Total	44	44	100
Other institutions	98	91	93
Hospitals	49	45	92
Research organizations	49	46	94

[1] The sample initially included five other institutions that were later classified as out of scope of the study.

KEY: HBCU = Historically black colleges and universities

SOURCE: National Institute of Health, *The Status of Biomedical Research Facilities: 1996,* Bethesda, MD, 1997

Item Nonresponse

After machine editing of questionnaire responses for completeness, internal consistency, and consistency with data from previous questionnaires, extensive telephone data retrieval was conducted to minimize the amount of missing or otherwise problematic responses to individual questionnaire items. As a result of these persistent follow-up activities, most of the individual items had very low item nonresponse rates.

Missing values were imputed for all questionnaire items that were involved in the data analysis. Missing data on total S&E fields were imputed based on the ratio of total academic space to total space in S&E fields. In Items 2 and 3, reported percentages were converted to NASF based on the amount of research space in Item 1. In Items 4, 6 and 8 (on completed capital projects, planned capital projects, and scheduled animal facility improvement), most missing values involved either missing costs or missing NASF, but not both. In these cases, the missing data element was imputed from the reported element, using 1994 data on average cost per NASF to estimate the one from the other.

Missing values that could not be imputed using the above methods were imputed using a "hot deck" approach. This involved imputing the missing value from a "donor" institution that did provide the needed information and that was as closely matched as possible to the institution with the missing information in terms of control, type (doctorate-granting or nondoctorate-granting) and FY 1994 research expenditures.

Weighting

After data collection, sampling weights were created for use in preparing national estimates from the data. First, within each weight class, a base weight was created for each institution in the sample.

The base weight is the inverse of the probability of selecting the institution for the sample. Second, because some institutions in the sample did not respond to the survey, the base weights were adjusted in each weight class to account for this unit nonresponse. Finally, the weights were adjusted again to bring the number of estimated institutions in accordance with the known number of institutions in various categories. For this final "poststratification" adjustment the institutions were classified by type (top 100 in research expenditures, other doctorate-granting, nondoctorate-granting), control, and HBCU status. The poststratified weights were used to produce the estimates shown in this report. The weighting procedures were essentially the same as those employed in the 1988, 1990, 1992 and 1994 studies.

Reliability of Survey Estimates

The findings presented in this report are based on a sample and are therefore subject to sampling variability. Sampling variability arises because not all institutions are included in the study. If a different sample of institutions had been selected, the results might have been somewhat different. The standard error of an estimate is a statistic often used to measure the extent of sampling variability for that particular estimate.

One of the ways that the standard error can be used to measure the amount of sampling variability is in the construction of confidence intervals. If all possible samples were selected and surveyed under similar conditions, then the intervals of 2 standard errors below the estimates to 2 standard errors above the estimates would include the average result of these samples in about 95 percent of the cases. Since only one sample is actually selected and surveyed, we must estimate the standard error from the sample itself. The interval constructed using the estimated standard error from the sample is called a 95 percent confidence interval. Estimated standard errors for selected statistics are shown in Table A-4.

Table A-4
Coefficients of variation for selected estimates from the NSF Survey of Academic Research Facilities: 1988-1996

ESTIMATE	1988 Survey		1990 Survey		1992 Survey		1994 Survey		1996 Survey	
	Estimate	Coefficient of variation	Estimate	Coefficient of variation	Estimate	Coefficient of variation	Estimate	Coefficient of variation	Estimate	Coefficient of Variation
BIOMEDICAL RESEARCH SQUARE FOOTAGE (in millions)										
All academic institutions	44.0	2.6%	45.9	3.7%	50.1	4.1%	51	3.7%	55	2.3%
Colleges and universities	21.4	3.9	22.5	6.5	23.3	6.5	23	3.9	26	3.
Medical schools	21.9	5.2	23.3	6.8	26.8	6.2	28	6.0	29	5.
Research organizations	4.4	10.0	4.8	26.8	5.1	9.0	6	14.9	6.5	5.
Hospitals	4.2	14.2	4.5	7.1	4.6	1.2	5	10.2	6.2	7.
ACTUAL REPAIR/RENOVATION COSTS FOR BIOMEDICAL RESEARCH SPACE (in millions of dollars)	(1986+ 1987)		(1988+ 1989)		(1990+ 1991)		(1992+ 1993)			
All academic institutions	$450	9.4%	$422	10.1%	$477	6.5%	486	7.1%	513	5.7%
Colleges and universities	198	16.7	185	20.0	188	5.6	136	6.4	186	9.
Medical schools	252	10.0	236	8.5	289	8.3	350	9.3	327	8.
Research organizations	24	25.0	29	18.2	30	22.0	38	49.4	31	7.
Hospitals	50	25.6	76	51.6	51	17.8	132	23.3	130	21.
ACTUAL NEW CONSTRUCTION COSTS FOR BIOMEDICAL RESEARCH SPACE (in millions of dollars)										
All academic institutions	$968	6.7%	$1,224	9.2%	$1,638	3.6%	1,632	9.0%	1,260	9.9%
Colleges and universities	527	10.3	456	11.0	602	3.7	452	11.4	509	22.
Medical schools	441	6.8	768	12..7	1,036	5.3	1,180	11.6	751	5.
Research organizations	116	14.3	76	21.1	118	18.1	180	20.7	67	92.
Hospitals	55	22.9	203	10.7	162	46.8	264	63.0	194	70.
PLANNED REPAIR/RENOVATION COSTS FOR BIOMEDICAL RESEARCH SPACE (in millions of dollars)	(1988+ 1989)		(1990+ 1991)		(1992+ 1993)		(1994+ 1995)			
All academic institutions	$403	4.6%	$424	5.1%	$596	5.3%	467	6.7%	560	5.7%
Colleges and universities	175	6.4	156	9.1	150	7.9	185	6.8	252	3.
Medical schools	228	5.5	268	7.9	446	7.5	282	9.5	308	9.
Research organizations	40	11.1	39	35.8	41	47.6	51	29.1	37	1`2.
Hospitals	77	27.2	32	20.1	39	13.9	63	36.6	46	29.
PLANNED NEW CONSTRUCTION COSTS FOR BIOMEDICAL RESEARCH SPACE (in millions of dollars)										
All academic institutions	$1,769	4.4%	$1,821	11.5%	$1,776	7.0%	1,489	7.6%	1,637	6.3%
Colleges and universities	551	7.3	669	3.7	541	5.1	454	9.2	751	14.
Medical schools	1,218	6.7	1,152	17.2	1,235	9.6	1,035	9.2	886	9.
Research organizations	62	7.0	150	10.7	130	8.8	150	28.9	55	60.
Hospitals	272	24.9	139	51.0	280	13.0	315	42.3	48	84.

SOURCE: National Institute of Health, *The Status of Biomedical Research Facilities: 1996,* Bethesda, MD, 1997

The standard errors for this study were estimated using a replication method called the jackknife repeated replication method. Using this method, the sample is divided into 13 replicates, and estimates are produced for each replicate. The variability among these replicate estimates is then used to estimate the standard error.

Data Considerations, Definitions, and Limitations

In addition to sampling errors, survey estimates can be adversely affected by nonsampling errors. Errors of this type include those resulting from reporting and processing of data. In this survey, extensive followup with respondents was used to ensure that the data were as accurate as possible. This included cross-year review that verified inconsistencies between the current and previous questionnaires.

Research Square Footage. In the 1994 survey, research was defined more broadly than in previous years, and this definition was continued in 1996. However, this change in definition has had little effect on how institutions actually reported S&E research space. Like the definition used in previous years, the 1994 definition included all R&D activities that are separately budgeted and accounted for. Unlike the previous definition, the 1994 definition also included departmental research that was not separately budgeted. Conversations with respondents from earlier surveys revealed that some departmental research had been included; thus, the current definition of research reflects what many institutions had been reporting all along.

In 1996, for the first time the survey included a definition of "net assignable square feet" (NASF). NASF was defined as the sum of all areas (in square feet) on all floors assignable to, or available to be assigned to, an occupant for specific use, such as instruction or research. It is unlikely that this inclusion had any effect on trends in this item.

Institutions' facility recordkeeping systems vary considerably. In general, most of the larger institutions have central computerized facility inventory systems, often based on space surveys conducted specifically for OMB Circular A-21. Many institutions with smaller research programs are not required to calculate square footage for OMB Circular A-21, and do not maintain databases that can provide such information. These institutions had to calculate or estimate square footage information specifically for this study.

Condition and Adequacy of Research Facilities. Questions eliciting assessments of the condition of S&E research space or its adequacy are by their very nature subjective. Two persons may make different assessments of the same facility or have different opinions of what is required in order for a facility to be suitable for a particular type of research. Despite the subjectivity involved, these items do capture an overall picture of the current status of facilities.

In 1996, the wording and response choice of the questions assessing both the condition of the institution's S&E research space and its adequacy were altered slightly from that used in previous years. Respondents were given only three possible choices for evaluating the adequacy of the amount of S&E research space: adequate, inadequate, or not applicable. Five choices had been provided in 1994. Response possibilities for assessing the current condition of S&E research space were reduced

from six choices in 1994 to four in 1996. Thus, percentage changes on these two items must be interpreted with some caution.

Capital Projects Involving Research Facilities. Few institutions maintain information on construction and repair/renovation projects specific to research facilities. Many capital projects involve both research and nonresearch space. When a project was not exclusively for research, institutions had to estimate the proportion of the project that was related to research facilities.

For projects taking more than one year to complete, institutions were asked to allocate the project to the fiscal year in which actual construction activity began or was scheduled to begin.

Because institutions use different dollar values to identify "major projects," this survey established a guideline to ensure consistency of reporting. As in previous cycles of the survey, projects with costs of $100,000 or more *associated with research facilities* were included. In 1992, 1994 and 1996, the surveys also had a separate question about costs of repair/renovation projects in the $5,000 to $99,999 range.

Dollar Amounts: Current versus Constant Dollars. In 1994, for the first time, capital project dollar amounts were reported in both constant and current dollars.   Both sets of numbers were included in the body of the report but discussion was limited to 1993 constant dollars. The 1996 report also uses both constant and current dollars but the reporting of these two figures differs from the 1994 report.

As in 1994, dollar amounts in 1996 were adjusted using the Bureau of the Census's Composite Fixed-Weighted Price Index for Construction. Unlike a more general index, this construction index closely tracks inflation within the construction industry. This index reflects only changes in prices and is unaffected by changes in the mix of construction projects during any given year.

Constant dollar tables in the 1996 report cannot be compared to constant dollar tables in the 1994 report.

Specific adjustments used for each of the fiscal years are presented in Table A-5.

Table A-5
Composite fixed-weighted price index for
construction inflation adjustments

Fiscal year	Average composite fixed-weighted price index for construction[1]
1986 - 1987	1.253
1988 - 1989	1.166
1990 - 1991	1.126
1992 - 1993	1.081
1994 - 1995	1.000

[1] The index for the second year was used in all calculations that spanned two fiscal years.

SOURCE: *National Institute of Health, The Status of Biomedical Research Facilities: 1996, Bethesda, MD, 1997*

Cost per Square Foot Data. The study did not collect unit cost data for individual construction or repair/renovation projects. It collected only the aggregate research-related costs and the aggregate research space involved across all projects begun during specified periods. These aggregates can be combined into indices of average cost per square foot, which are useful in tracking broad cost trends over time. However, they are of little practical value as guidelines for project planning. By all accounts, unit costs for both construction and repair/renovation projects are highly variable, depending on the specific requirements of the particular project and on many other factors as well (e.g., geographic region of the country). Such differences, which are of crucial importance in project planning, are obscured in the kinds of multiproject averages that can be constructed from this study's data.

Deferred Capital Needs. The 1996 survey added several questions in an effort to derive estimates of the S&E research facilities' needs of research-performing institutions. In 1994, institutions were asked to report on deferred construction and repair/renovation projects that were included in an approved institutional plan. In 1996, institutions reported separately the construction and repair/renovation costs for projects included in such plans, as well as for projects not included. In addition, institutions were asked to report their estimated central campus infrastructure needs, separately for construction and repair/renovation, and for both those in plans and those not in plans. This provided a more complete estimate of deferred capital projects.

In addition to this estimate of research facility needs based on institutions' reports of the S&E research construction and repair/renovation projects that had been deferred, the 1996 survey made additional efforts to measure this need. If institutions indicated that they had an inadequate amount of S&E research space in any given field (Item 2), they were asked to indicate the additional space needed. Institutions also were asked to report either the amount or percent of that space that was funded and

scheduled to undergo major renovation or replacement (Item 3). It was thus possible to derive estimates of the amount of additional space needed and the amount of repair/renovation needed and not scheduled. Average construction and repair/renovation costs per square foot were used to derive another dollar estimate of research facility needs.

Both of these approaches, based on different assumptions, are believed to provide conservative estimates of the research facility needs of research-performing institutions.

APPENDIX B

SURVEY INSTRUMENT